Measurements of Aged Aircraft Exhaust in the ACCENT Mission

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The Atmospheric Chemistry of Combustion Emissions Near the Tropopause (ACCENT) mission is a multi-agency sponsored effort to evaluate the roles of aircraft and rocket exhaust in perturbing ozone chemistry and modifying aerosols and clouds. During the 1999 ACCENT campaigns, the NASA WB-57F aircraft flew a number of successful sorties intercepting multiple aged plumes of aircraft over the Dallas, Texas area between 9 and 13 km and intercepting wakes of Atlas IIAS, Delta II, and Athena II launch vehicles between 18 and 19 km altitude. For the aircraft plume measurements flight planning relied on meteorological forecasts of aircraft exhaust accumulation. Measurements of elevated NO_x were made in the studied area and attributed to aircraft exhaust based on trajectory calculations and chemical tracer measurements.

Measurements made during ACCENT include particle composition, black carbon and volatile aerosol concentrations, particle size distribution, and concentrations of a number of gas-phase species. We will present a survey of data obtained during the ACCENT plume wake missions and discuss how the data will add to an improved understanding of the natural aerosol background as well as the composition and atmospheric processing of aircraft-derived aerosols.

ACCENT

(Atmospheric Chemistry of Combustion Emissions Near the Tropopause)

Science Questions

1) Is cloud formation in the upper troposphere limited by cloud condenstion nuclei or ice nuclei?
2) Do aircraft significantly effect the density or composition of upper troposphere and/or lower stratosphere aerosol?
3) Do aircraft-derived particles in the lower stratosphere provide effective surfaces for ozone depletion or reactions of nitrogen oxides?

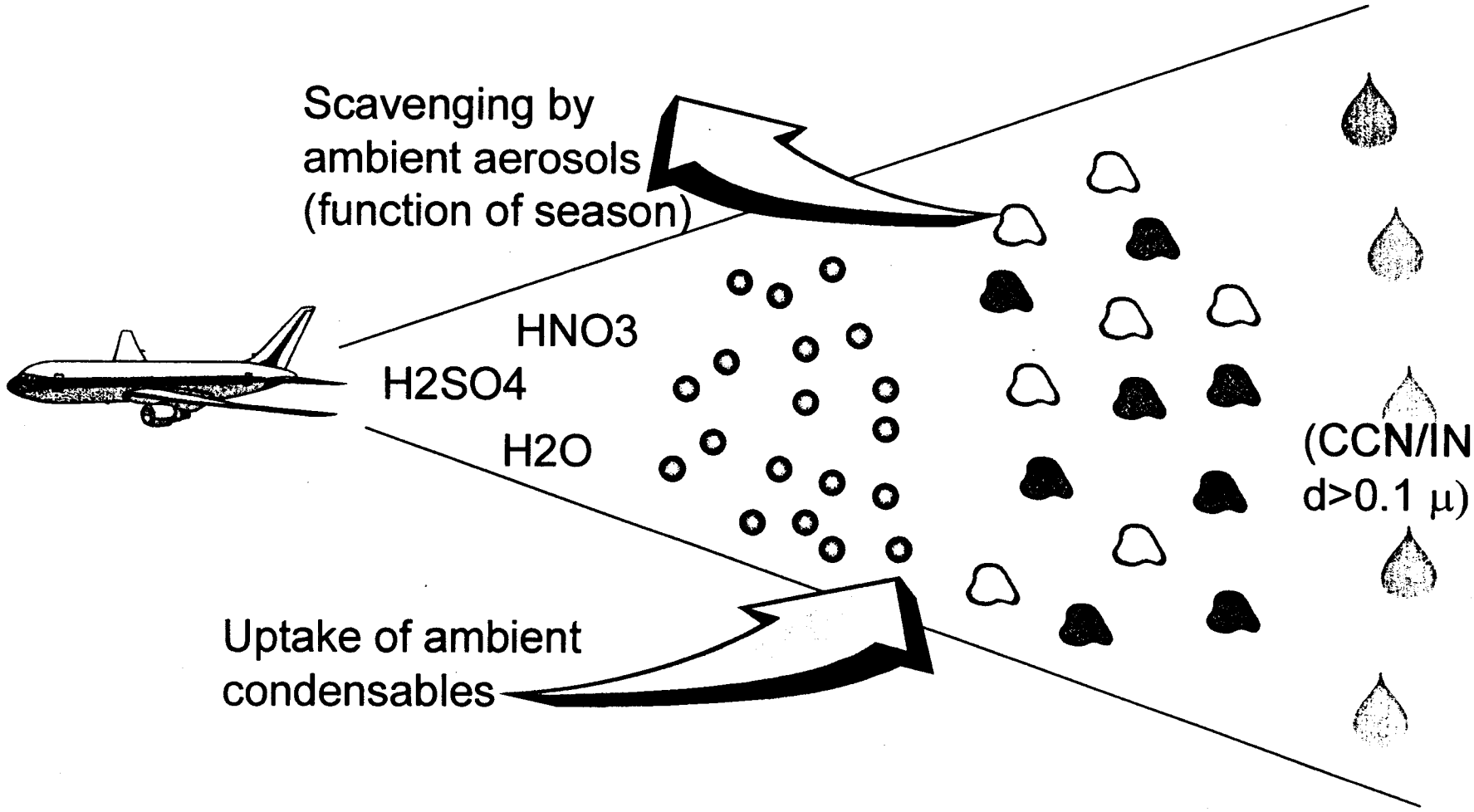
Mission Objectives (re aircraft emissions)

1) Measure the distribution and characteristics of aerosol in and around continental air traffic corridors.
2) Relate measured particle features to primary aerosol sources through correlation with measured gaseous tracers.
3) Obtain simultaneous measurements of CN, CCN, and particle composition in air heavily influenced by aviation.
4) Identify important functional relationships between cirrus clouds, water vapor, sulfate, soot, other gases, and temperature near the tropopause in spring and fall.

Chasing the Indirect Effects

- Cirrus cloud increase observed over US (up to 4% per decade). Correlates with observed contrail increases.
- Increasing frequency of enhanced CN layers over Laramie, Wyoming suggest discernable aircraft perturbation
- CCN measurements in SUCCESS suggest that aircraft-derived aerosol is CCN enhanced.
- Model calculations indicate that cirrus increases likely due to surface sulfate and soot rather than aircraft unless dust is the dominant ice forming nuclei.

Aircraft-Generated CCN



Quantifying CCN Perturbations

Empirical Approach:

Aircraft particle # = fuel burn x particle EI x lifetime correction
= 3x10(-14) x 10(16) x 0.3 = 100 cm-3
Ambient bkgd # = typical UMR, Denver U. measurements
= 1000 cm-3

CCN increase from aircraft → **10% in accumulation sites**

Model Approach

Construct model that explicitly treats competition between scavenging by ambient aerosols and uptake of ambient condensables

Yu&Turco Model → **CCN increase from aircraft** → **5% globally 100% in corridor**

ACCENT Mission Summary

Spring Deployment

4/5	Deployment start
4/7	Test flight to Albuquerque, New Mexico (jet stream transit)
4/9	Test/Science flight to CCAS, Florida
4/12	Atlas IIAS rocket sampling at CCAS
4/15	Delta II rocket sampling at VAFB
4/22	Sampling of Gulf air influenced by convection from Tropical Pacific
4/23	Sampling of Gulf air influenced by convection from Tropical Pacific ← Thursday poster

Fall Deployment

8/31	Deployment start
9/3	Test flight to Topeka, Kansas (RAOB sites overpass)
9/8	Test flight to Topeka, Kansas
9/13	Test flight to Atlantic Ocean
9/15	Hurricane Floyd overflight
9/17	Aircraft exhaust sampling near Dallas, Texas
9/20	Tropical air sampling with landing in Costa Rica
9/21	Tropical air sampling on return flight from Costa Rica
9/22	Test flight into stratosphere
9//24	Athena rocket sampling at VAFB

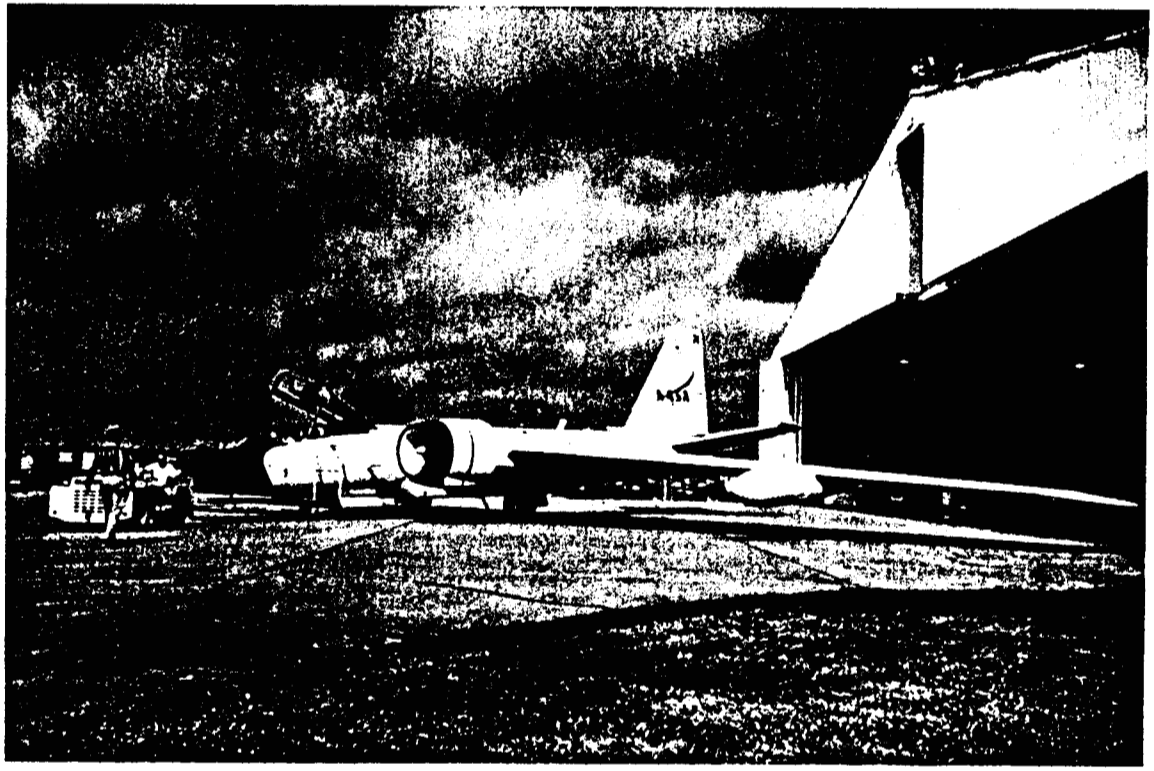
INSTRUMENT	MEASUREMENT	PRINCIPAL INVESTIGATOR
PTW	pressure, temperature, and winds	T. L. Thompson NOAA
MTP	microwave temperature profile	M. J. Mahoney Jet Propulsion Laboratory
CORE	ClO, CO_2	D. W. Toohey University of Colorado
LACE	Gas chromatography	J. Elkins NOAA
MASP	aerosol size and concentration	B. W. Gandrud NCAR
PALMS	individual particulate composition	D. Murphy NOAA
FCAS	aerosol size and concentration	J. C. Wilson
CNC	aerosol surface area	C. Brock
NMASS	sample return	University of Denver
RPM		P. D. Whitefield
GTS	aerosol size and concentration	University of Missouri - Rolla
TDL	CH_4	E. C. Richard NOAA
NIRTDL	CO and N_2O	M. Coffey W. Mankin NCAR
NOAA Ozone	O_3	E. C. Richard NOAA
PSI Ozone	O_3	W. T. Rawlins Physical Sciences Inc.
H_2O	total water open path water	K. K. Kelly, NOAA C. Webster, JPL
WAS	gaseous tracers	E. Atlas NCAR
CCN	cloud condensation nuclei	R. Flagan Cal Tech
NCAR NO_Y	reactive nitrogen	B. Ridley NCAR
NOAA CIMS	HNO_3	R. S. Gao D. W. Fahey NOAA
METEOROLOGICAL ANALYSIS	UT/LS meteorological and aircraft exhaust exposure predictions	P. A. Newman GSFC H. B. Selkirk NASA Ames K. Rosenlof NOAA

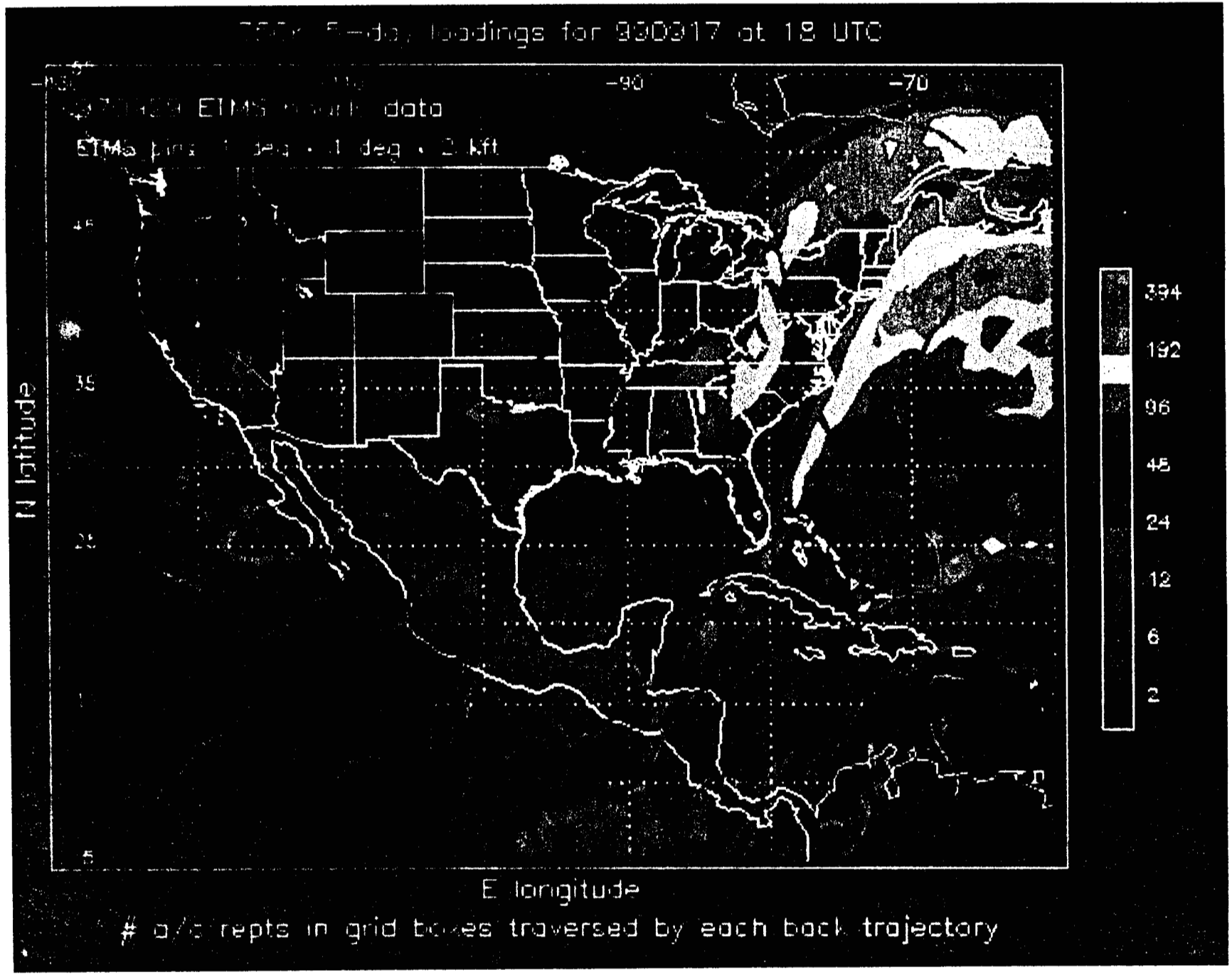
CPFM

MISSION MANAGEMENT

T. McElroy

R. FRIEDL, M. ROSS
A. TUCK

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a/c repts in grid boxes traversed by each back trajectory